

APPENDIX C4 IMPACTS OF THE PROPOSED PROJECT RELATIVE TO THE NO-PROJECT ALTERNATIVE

This appendix provides a qualitative analysis of potential effects on aquatic resources with implementation of the Proposed Project, relative to the No-Project Alternative. Although the following topical outline is consistent for analysis of both alternatives, effects on several issue areas are not anticipated to occur under the Proposed Project. From an aquatic resources perspective, there are only a few differences between the No-Project Alternative and the Proposed Project. (See Section 3.3, Description of Alternatives under Consideration, for a detailed description of the Proposed Project and No-Project Alternative conditions.) Net flow releases from the Oroville Facilities and reservoir water surface elevation fluctuations are anticipated to be the same as those under the No-Project Alternative with implementation of the Proposed Project. Therefore, no quantitative analysis is required or provided to analyze potential effects on aquatic resources associated with Feather River flow changes below the Thermalito Afterbay Outlet or reservoir surface elevation changes and the resultant effects on the quantity, quality, or distribution of fish habitat. The analysis of potential effects on aquatic resources in the Low Flow Channel (LFC) is partially quantitative based on previous modeling and Instream Flow Incremental Methodology studies conducted as part of the Preliminary Draft Environmental Assessment (PDEA).

Actions included in the Proposed Project that are relevant to a partial quantitative assessment of effects on aquatic resources, and that are not included in the No-Project Alternative, consist of changes in water temperature management at Robinson Riffle and increases in minimum flows in the LFC. Under the Proposed Project, flows in the LFC would increase from 600 cubic feet per second (cfs) to 700 cfs from April 1 through September 14 and 800 cfs from September 15 through March 31. These flow and temperature changes are evaluated in the subsections below. Additional description and analysis of the flow changes are available in Section 5.2, Surface Water Quantity and Quality. A detailed description of the methodology used to analyze potential effects on aquatic resources is provided in Appendix C1, Aquatic Resources Methodology.

Actions included in the Proposed Project that are relevant to the qualitative assessment of the effects on aquatic resources, and that are not included in the No-Project Alternative, consist of (1) installation of fish segregation weirs for the segregation of spring-run Chinook salmon spawning; (2) supplementing and improving large woody debris (LWD) in the lower Feather River; (3) supplementing and improving gravel substrate in the lower Feather River; (4) improving existing and creating new side-channel fish habitat; (5) implementation of a comprehensive water quality monitoring program that includes establishment of water temperature targets at the lower Project Boundary and the Feather River Fish Hatchery; and (6) implementation of a habitat expansion program for spring-run Chinook salmon. These actions included in the Proposed Project are evaluated qualitatively in the subsections below.

In addition to the actions described above, the Settlement Agreement (SA) identified six potential future facility modifications that are being studied and compared for their potential to improve water temperatures in the LFC and High Flow Channel (HFC) to support anadromous salmonids over the term of the Federal Energy Regulatory Commission (FERC) license. Measures identified for study include (1) Palermo Canal improvements; (2) a Hyatt Intake extension; (3) refurbishment of the river valve; (4) a canal around Thermalito Afterbay; (5) a canal through Thermalito Afterbay; and (6) an alternate Thermalito Afterbay outlet and channel. Descriptions of these modifications are provided in Section 3.3. For purposes of this analysis, effects of potential future facility modifications on each fish species of management concern are evaluated qualitatively based on the general characteristics of each of the measures as they are currently defined and understood for each fish species of management concern following the qualitative evaluation used to describe conditions during the initial new license operating period prior to the construction of facilities modifications. The environmental effects of the potential future facilities modifications selected will be quantitatively evaluated in a subsequent environmental document, prior to their construction.

C4.1 HABITAT COMPONENTS AFFECTED BY THE OROVILLE FACILITIES

Implementation of some of the actions in the Proposed Project may involve instream construction activities or construction activities within areas adjacent to water bodies in the project area. Utilization of specific design elements, construction techniques, and aquatic conservation measures are incorporated in the proposed measures to minimize and avoid construction-related effects on species of management concern within the immediate vicinity of and downstream from the construction area. Construction activities will be scheduled to avoid impacts during critical life stages when those life stages would be unable to volitionally avoid the construction area (e.g., during salmonid embryo incubation). Additionally, construction-related effects on fisheries resources would be reduced through the implementation of standard construction best management practices (BMPs), and, if necessary, Erosion and Sediment Control Plans.

C4.1.1 Chinook Salmon Spawning Segregation

One or more fish segregation weirs would be installed in the lower Feather River downstream of the Fish Barrier Dam and upstream of the Thermalito Afterbay Outlet with implementation of the Proposed Project. Installation of fish segregation weirs may provide for some level of segregation between spring- and fall-run Chinook salmon and would reduce some of the adverse effects of high spawning densities in this reach of the lower Feather River. Appropriately placed weirs could potentially simulate historic spatial segregation of runs by selectively allowing or blocking fish passage on a temporal basis.

In addition to providing a mechanism for segregation of spring- and fall-run Chinook salmon, the fish segregation weirs would reduce the rates of redd superimposition and the resulting egg mortality for spring-run Chinook salmon. (For a discussion of redd superimposition, particularly in the lower Feather River, see Study Plan [SP] F10, Task

2B, *Evaluation of Potential Effects of Facilities Operations on Spawning Chinook Salmon*, in Section G-AQUA1.8.2 in Appendix G-AQUA1 in the PDEA.) Using the fish segregation weirs would allow management of available habitat to limit the number of early arriving spawners allowed to enter a portion of the LFC reserved as a spring-run Chinook salmon spawning preserve, thus limiting the rate and adverse effects of redd superimposition, and the level of competition for limited habitat, and the resulting contribution to pre-spawn mortality rates on spring-run Chinook salmon.

Other potential benefits of installing weirs in the lower Feather River include providing a mechanism to allow collection of valuable data on timing, abundance, and movements of Feather River fish species. The installation of fish weirs would provide a flexible management tool for the reach of the Feather River between the Fish Barrier Dam and the Thermalito Afterbay Outlet.

Two fish weirs are proposed as part of the Proposed Project. The proposed location for the weir farthest upstream is near Bedrock Park at approximately River Mile (RM) 66. The proposed location for the second weir is downstream near Gateway Riffle at approximately RM 60. Installation of weirs in the lower Feather River may create some potential resource conflicts and necessitate some changes to project operations. For example, weirs could conflict with current fishing and boating recreation in this reach of the Feather River. See Section 5.7.4, *Recreational Resources Impacts and Mitigation Measures*, for additional information on the potential recreational effects of this action. Additionally, placement of the upper weir at Bedrock Park would inhibit collection of fall-run Chinook salmon brood stock through the existing fish ladder located at the Fish Barrier Dam. The upstream fish segregation weir would include an egg taking station to replace fall-run Chinook salmon access to the Feather River Fish Hatchery fish ladder. The current locations under consideration for the implementation of the fish weirs are provisional and subject to review and comment by the Ecological Committee (EC). Fish weir installation would be subject to more detailed environmental impacts analyses in a subsequent environmental document prior to the implementation of this action.

C4.1.2 Macroinvertebrate Populations

Macroinvertebrate communities in the lower Feather River likely would benefit from implementation of the Proposed Project. LWD supplementation would benefit macroinvertebrates by increasing habitat diversity and contributing organic nutrients. Gravel supplementation and improvement would reduce substrate armoring, thereby improving the quality of macroinvertebrate habitat. The side channel improvement of Moe's Ditch and Hatchery Ditch and the creation of new side channel habitat also would offer increased and more diverse habitat for aquatic macroinvertebrates.

C4.1.3 Woody Debris Recruitment

Implementation of the Proposed Project would include supplementing LWD in the lower Feather River to satisfy fish habitat improvement goals for the duration of the license period. The reach of the Feather River extending from the Fish Barrier Dam downstream to the Thermalito Afterbay Outlet is used intensively as spawning habitat

for anadromous salmonids. LWD supplementation would (1) contribute to both the geomorphic and ecological functions of the lower Feather River; (2) enhance rearing habitat for juvenile salmonids by providing cover; (3) create scour pools that may serve as holding habitat for anadromous salmonids; (4) trap sediment, allowing recruitment of riparian vegetation; and (5) decaying LWD would provide an additional source of instream nutrients for aquatic organisms. Additionally, LWD placed or recaptured in backwater mesohabitats below the Thermalito Afterbay Outlet may enhance habitat for warmwater species such as black bass, but could also potentially contribute to bass predation of juvenile salmonids to the extent that it does benefit these black bass species.

The Proposed Project includes the placement of LWD in the lower Feather River primarily from the Fish Barrier Dam to the Thermalito Afterbay Outlet, and possibly in other locations downstream of the Afterbay Outlet. In general, single logs, groups of logs, or combinations of logs and boulders that are anchored or cabled together would be placed in the river (Flosi et al. 1998). Anchoring would probably be required for projects that are intended to be site specific, such as riprapped banks or side channels. Wood may also be anchored at banks with cables or between natural or artificial structures.

Placement of LWD could create conflicts with landowners adjacent to the channel if bank erosion is inadvertently increased as a result of LWD-related flow diversion. (See Section 5.6 for additional information on potential effects of a LWD supplementation program on land use.) Placement of LWD could also decrease river navigability in some areas. See Section 5.7.4 for additional information on potential effects of a LWD supplementation program on recreation.

Under current regulated-flow regimes, placements of LWD would provide localized benefits for fish habitat until a high flow event. When a flood control event occurs, the magnitude of the flow event would redistribute both naturally recruited and supplemented LWD. This redistribution is a normal ecosystem function; however, the LWD in the upstream reaches of the LFC would need to be replaced or augmented following these events. In the event that LWD moves out of the Feather River during extreme flow events, it would provide fish habitat benefits downstream on the Sacramento River.

Because the specific methods, timing, and locations of the LWD placement program would be developed as an early license implementation task and are subject to EC review and comment, the LWD program would be subject to a more detailed analysis in a subsequent environmental document prior to the implementation of this action.

C4.1.4 Gravel Recruitment

The Proposed Project includes supplementing gravel in the lower Feather River at selected anadromous salmonid spawning riffles between the Fish Barrier Dam and Honcut Creek that would benefit from spawning substrate improvement. The Proposed Project also provides for the ripping and raking of substrate in selected potential

salmonid spawning areas of the lower Feather River where the substrate has become armored or sufficiently coarsened in particle size distribution to reduce salmonid spawning habitat quality. (See Section 4.1, Geology, Soils, and Paleontological Resources, for additional information on gravel conditions.)

Sites that may benefit from gravel supplementation were identified in SP-G2. Depending on the findings of surveys conducted after gravel supplementations, additional supplementations may be conducted in the same areas or certain sites may be abandoned. Likewise, potential sites that may benefit from ripping and raking were identified in SP-G2. Future surveys may determine other areas where substrate ripping and raking of substrate may enhance spawning habitat.

Information gathered from SP-G2 has identified specific sites downstream of the Fish Barrier Dam and upstream of the Thermalito Afterbay Outlet that may benefit from supplementation of spawning gravel. Supplementation of gravel at these locations is intended to increase suitable spawning habitat quality and quantity for anadromous salmonids by restoring habitat substrate. The spawning gravel supplement and improvement program would provide the greatest benefit to spawning areas in the upstream-most portions of the LFC below the Fish Barrier Dam because they currently have the most coarsened substrate particle size distribution which currently is only marginally suitable for salmonid spawning. Additionally, gravel supplemented near the base of the Fish Barrier Dam would be mobilized during high flow events and would be redistributed downstream, mimicking normal gravel recruitment. Subsequent gravel placements would be required after future peak-flow events to maintain benefits provided by supplementation of spawning gravel. The improvement of spawning substrate in the upstream reaches of the LFC complements the function of the fish segregation weirs, spatial segregation of spring-run Chinook salmon by providing habitat enhancements in those locations that provide direct benefits to Endangered Species Act-listed species (i.e., spring-run Chinook salmon and steelhead).

Because the specific methods, timing, and locations of the gravel supplementation program would be developed as an early license implementation task and are subject to EC review and comment, the gravel supplementation program would be subject to a more detailed analysis in a subsequent environmental document prior to the implementation of this action.

C4.1.5 Channel Complexity

Implementation of the Proposed Project includes enhancement of existing side-channel habitat in Hatchery Ditch and Moe's Ditch, both located downstream of the Fish Barrier Dam adjacent to the Feather River Fish Hatchery. Enhancements to these existing side channels could include reforming the channel for increased water depth and shoreline diversity, placing boulders and woody debris for cover and velocity diversity, and gravel substrate supplementation. Moe's Ditch may also include removal of a beaver dam which currently blocks flow at the downstream end of the channel (see "Wildlife" in Section 5.5.1, Terrestrial Resources, for additional discussion). The enhancement of

these existing side channels would primarily benefit steelhead and spring-run Chinook salmon by increasing the quantity and quality of spawning and rearing habitat.

Additionally, the Proposed Project includes development of five additional side channel riffle/glide complexes over a 5-year period, which would provide a minimum of 2,460 feet of new spawning and rearing habitat for Chinook salmon and steelhead. All side channels created would be adjacent to existing riffle complexes and would approximate historic habitat with respect to base flow ranges and other environmental conditions. Side channel flows likely would range between 10 cfs and 75 cfs and should be designed to provide appropriate depth, velocity, substrate, and instream and riparian cover to benefit primarily juvenile salmonid rearing, but also to some extent potentially benefit steelhead spawning as specific side channel construction site conditions allow. To the extent possible, side channel development would coincide with gravel supplementation activities or other habitat improvement measures occurring in the vicinity to minimize habitat disruption, as well as facilitate complementary design features between the actions.

Because the methods, timing, and locations of the side channel enhancement and creation would be developed as an early license implementation task and are subject to EC review and comment, the Channel Complexity Program would be subject to a more detailed analysis in a subsequent environmental document prior to the implementation of this action.

C4.1.6 Water Quality Criteria for Aquatic Life

Water quality conditions for aquatic life are not expected to change with implementation of the Proposed Project, with the exception of any short-term water quality effects associated with instream construction activities. See Section 5.2.2, Surface Water Quality, for the evaluation of construction-related effects on water quality.

As part of the Proposed Project, permanent continuous water temperature monitoring devices would be installed at the Feather River Fish Hatchery, Robinson Riffle, the Thermalito Afterbay Outlet, and in the lower Feather River adjacent to the lower Project Boundary.

C4.1.7 Facilities Modifications

A measure in the Proposed Project is intended to provide water temperatures in the Feather River Fish Hatchery suitable for all salmonid life stages as needed to achieve production goals. Project operations and/or facilities would be modified to meet temperature objectives as specified in Table C4.1-1.

Table C4.1-1. Initial new license operating period water temperature targets for the Feather River Fish Hatchery.

Time Period	SA Table 107A Daily Mean Maximum (°F)	SA Table 107B Hourly Mean Maximum (°F)
September	56°	56°
October–November	55°	55°
December–March	55°	55°
April–May 15	55°	55°
May 16–May 31	55°	59°
June 1–June 15	60°	60°
June 16–August 15	60°	64°
August 16–August 31	60°	62°

Source: DWR 2006

The temperatures in the second column of Table C4.1-1 are the maximum daily mean temperature targets for the initial new license operating period that the California Department of Water Resources (DWR) would seek to achieve through the use of operational measures until facilities modifications are completed. After any future facility modifications are completed and no later than the end of year ten following license issuance, these temperatures would become requirements. At that time, water temperature objectives listed in the table may be altered, but would not become less protective than those depicted in the second column. The hourly maximum temperatures depicted in the third column of Table C4.1-1 represent the upper end of the existing hatchery temperature criteria and at no instance shall DWR exceed these temperatures. There shall be no minimum temperature requirement except for the period of April 1 through May 31, during which the temperatures shall not fall below 51 degrees Fahrenheit (°F). See Section 3.3 for a more detailed description of the hatchery water temperature target and potential requirement development after the construction and testing of facilities modifications.

The Proposed Project also includes the development of water temperature requirements for the HFC as measured at the lower Project Boundary. Upon completion of facilities modifications, temperatures depicted in Table C4.1-2 would be evaluated and new targets will be developed, achievement of which at the Project Boundary would be verified, during a testing period. During the initial new license operating period facilities operations would not be changed to meet the temperatures depicted in Table C4.1-2. At the end of the initial new license operating period, when facility modifications have been completed, there would be 5 years of operational testing to determine what water temperatures can be achieved at the lower Project Boundary. After testing and verification that they could be achieved, these water temperatures would become requirements. See Section 3.3 for a more detailed description of the Table 1, Robinson Riffle, and Table 2, lower Project Boundary, water temperature targets and potential requirements development after the construction and testing of facilities modifications.

Table C4.1-2. Initial new license operating period water temperature objectives (maximum mean daily value) for the HFC at the downstream lower Feather River project boundary.

Month	Water Temperature (°F)
April	61°
May–August	64°
September	61°
October	60°
November–March	56°

Source: DWR 2006

Because the potential facilities modifications have not been selected, the design details have not been defined, and the potential combinations of measures have not been selected, the final water temperature requirements as well as the other potential resources effects are currently unknown and cannot be evaluated in detail at this time. As a result of the unavailability of the definitive characteristics of this action, only the general characteristics of the potential facilities modifications can be qualitatively evaluated for their potential effects on the aquatic resources. The potential facilities modifications would be evaluated in detail in a subsequent environmental document prior to their construction.

Potential facility modifications are described in Section 3.3. Each of the measures being studied would be designed to reduce water temperatures in the LFC and HFC of the lower Feather River and if implemented would benefit coldwater fisheries, particularly anadromous salmonids. DWR has identified seven measures for study.

The Palermo Canal improvements, Hyatt intake extension, and river valve improvement measures are each conceptualized as a potential means of increasing access to coldwater pool reserves in Lake Oroville. These measures that could increase coldwater pool access are primarily designed to improve water temperatures at the Feather River Fish Hatchery and in the LFC from the Fish Barrier Dam downstream to Robinson Riffle, the Table 1 water temperature target location. These measures would also be intended to reduce water temperatures below Robinson Riffle in the LFC and to improve water temperature conditions in the HFC from the Thermalito Afterbay Outlet downstream to the lower Project Boundary, the proposed lower Project Boundary water temperature target location. Both the river valve modifications and the Hyatt intake extension would enable release of cold water from Lake Oroville into the Diversion Pool and reduce the water temperatures of the entire volume of water released from the lake. Cooling the entire volume of water released from Lake Oroville would reduce water temperatures in the Diversion Pool and Thermalito Forebay, benefiting those coldwater fisheries resources, the Feather River Fish Hatchery water intake, and the coldwater fisheries resources in the lower Feather River downstream from the Fish Barrier Dam. Because water temperatures are reduced for the entire volume of water released from Lake Oroville, water temperatures in the Thermalito Afterbay also would be reduced, which would reduce the quantity and quality of warmwater fisheries habitat. The

Palermo Canal improvements would release cold water at the intake for the Diversion Dam and minimize the mixing of the cold water release with the water volume in the Diversion Pool prior to discharge to the lower Feather River. Therefore, the Palermo Canal improvements would not benefit the coldwater fisheries in the Diversion Pool or the Thermalito Forebay, but also would not reduce the quantity or quality of warmwater fisheries in the Thermalito Afterbay. The Feather River Fish Hatchery water supply intake would be provided by a portion of the Palermo Canal improvement facilities releases to blend with the Diversion Pool supplies to meet the hatchery water temperature requirements. The upper portion of the LFC would benefit from the release of cold water from the Palermo Canal as a result of improved water temperature suitability for coldwater fisheries. The remainder of the Palermo Canal improvement releases would be transported via pipeline for release at a location farther down the LFC to further enhance the quantity and quality of available coldwater fisheries habitat. Two of the potential locations under consideration for the potential release of this second component of flow from the Palermo Canal improvements are immediately above Robinson Riffle in the LFC or at the bottom of the LFC immediately above the Thermalito Afterbay Outlet. The release location of the second flow component from the Palermo Canal improvements would be one of the items studied during future feasibility studies and would be subject to review and comment by the EC. It should be noted that the potential biological benefits of the flow release above Robinson Riffle would be substantially higher than the benefits of release at the Afterbay Outlet. The increased biological benefit of this release location is due to increased spawning habitat suitability for the spawning areas at and immediately downstream of Robinson Riffle, the opportunity to create a side channel that utilizes the discharge water, which could be designed to benefit steelhead spawning and rearing (the most limited type of habitat in the lower Feather River), and avoiding creating a coldwater refugium that could prolong spring-run Chinook salmon holding in the Afterbay Outlet Pool, which has the highest fishing pressure and poaching potential in the lower Feather River.

The four Thermalito Afterbay facilities measures under consideration are each intended to complement the coldwater pool access device and primarily benefit the water temperatures in the lower Feather River below the Thermalito Afterbay Outlet downstream to the lower Project Boundary, which is the Table 2 water temperature target location. The four afterbay measures are (1) a canal around the Thermalito Afterbay; (2) a canal through the Thermalito Afterbay; (3) an extension of the current Thermalito Afterbay outlet to release water farther downstream near the lower Project Boundary; and (4) a Thermalito Afterbay water temperature curtain. Of the potential Thermalito Afterbay modifications, the canal around the Thermalito Afterbay, canal through the Thermalito Afterbay and the Thermalito Afterbay water temperature curtain may provide cooler water temperatures in the HFC during the spring and early summer, but may result in warmer water temperatures in the late summer and fall. The canal through the afterbay may reduce the water temperatures along the northern margins of the afterbay, depending on the specific facilities design, which would result in a water temperature reduction in the locations of the majority of the black bass spawning which could potentially affect the sustainability of this recreational fishery. The Thermalito Afterbay curtain may help mitigate the impacts of any upstream measures on water

temperatures in the afterbay. This measure would utilize a baffle (temperature curtain) to direct cold water through the eastern portion of the afterbay, thus allowing colder water to flow through the afterbay faster while increasing the residence time of warmer water utilized for agricultural diversions from the western side. The Thermalito Afterbay Outlet extension would likely perform best for water temperature reduction in the lower Feather River as LFC water temperatures would be allowed to continue farther downstream before the Thermalito Afterbay discharge would be mixed with the cooler LFC water. It should be noted that the majority of the anadromous salmonid spawning habitat occurring in the HFC occurs upstream of the discharge location discussed for the Afterbay Outlet extension.

C4.1.8 Habitat Expansion

The habitat expansion measure included in the Proposed Project (SA Appendix F) is an effort to increase production of spring-run Chinook salmon and steelhead. The goal of the measure is to expand existing habitat within the Sacramento River basin to accommodate an increase of 2,000 to 3,000 spring-run Chinook salmon or steelhead for spawning. Potential habitat actions likely would not occur within the Project Boundary. Potential measures include dam removal, flow and water temperature improvements, new fish passage structures or programs, improvement of existing fish passage structures and programs, gravel supplementation at existing habitat, or riparian vegetation enhancements. Habitat expansion actions also would include future operation and maintenance actions if required after implementation, but would not include long-term monitoring of species utilization or benefit.

Because the nature and locations of the habitat expansion actions are not currently known and are subject to National Marine Fisheries Service review and approval prior to implementation, the potential affects of the habitat expansion actions would be subject to subsequent environmental documentation and analysis prior to the implementation of this action.

C4.2 WARMWATER RESERVOIR FISHERIES

C4.2.1 Operations-Related Effects

C4.2.1.1 Spawning and Initial Rearing

No changes in reservoir water surface elevations, rates of reduction, or surface elevation fluctuations in Lake Oroville or the Thermalito Afterbay are anticipated with implementation of the Proposed Project. Therefore, the potential for bass nest dewatering would not change as compared with the No-Project Alternative.

Consequently, no impacts on black bass spawning and rearing are anticipated with implementation of the Proposed Project relative to the No-Project Alternative.

C4.2.1.2 Fish Interactions

No changes in fish stocking or in the frequency of sediment wedge exposure from Lake Oroville water surface elevation fluctuations are anticipated with implementation of the Proposed Project. Interactions among fish species upstream of Oroville Dam are anticipated to be the same under the Proposed Project relative to the No-Project Alternative.

C4.2.2 Fisheries Management–Related Effects

C4.2.2.1 Stocking

No changes in warmwater fish stocking or the habitat enhancement program are anticipated with implementation of the Proposed Project relative to the No-Project Alternative.

C4.2.2.2 Disease

No changes in the types of warmwater fish diseases or rates of disease transmission are anticipated with implementation of the Proposed Project relative to the No-Project Alternative.

C4.2.2.3 Recreational Access or Fishing Regulations

Recreation enhancements included in the Proposed Project are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access would be increased through the construction of a fishing pier or platform at the Diversion Pool and South Forebay Day Use Area (DUA), and increased shoreline access in the north Forebay through the construction of trails. See Section 5.7.4 for additional information on recreation enhancements. No changes in regulations for warmwater sport fishing are anticipated with implementation of the Proposed Project relative to the No-Project Alternative. Increased access and consequent increased harvest of warmwater fish species with no corresponding changes to current regulations could negatively impact warmwater species within the project area.

C4.2.3 Summary of Potential Effects on Warmwater Reservoir Fisheries

Implementation of the Proposed Project would be beneficial to the quality or quantity of warmwater fish habitat available in Lake Oroville but not other Oroville Facilities reservoirs relative to the No-Project Alternative. However, increased levels of harvest could have a negative impact on warmwater fish populations in some of these reservoirs.

C4.3 COLDWATER RESERVOIR FISHERIES

C4.3.1 Operations-Related Effects

C4.3.1.1 Habitat Availability

No changes in reservoir water surface elevations and the associated quality and quantity of effective available coldwater pool habitat in Lake Oroville are anticipated with implementation of the Proposed Project. Therefore, no changes to coldwater fish habitat are anticipated under the Proposed Action relative to the No-Project Alternative.

C4.3.1.2 Fish Interactions

No changes in fish stocking or in the frequency of sediment wedge exposure from Lake Oroville water surface elevation fluctuations are anticipated with implementation of the Proposed Project. Therefore, no differences in fish species interactions upstream of Oroville Dam, in the Thermalito Forebay, or in the Thermalito Afterbay are anticipated with implementation of the Proposed Action relative to the No-Project Alternative.

C4.3.2 Fisheries Management–Related Effects

C4.3.2.1 Stocking

No changes in coldwater fish stocking are anticipated with implementation of the Proposed Project relative to the No-Project Alternative.

C4.3.2.2 Disease

No changes in potential exposure to fish diseases are anticipated with implementation of the Proposed Project relative to the No-Project Alternative.

C4.3.2.3 Recreational Access or Fishing Regulations

Recreation enhancements included in the Proposed Project are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access would be increased through the construction of a fishing pier or platform at the Diversion Pool and South Forebay DUA and increased shoreline access in the North Forebay through the construction of trails. See Section 5.7.4 for additional information on recreation enhancements. No changes in regulations for coldwater sport fishing are anticipated with implementation of the Proposed Project relative to the No-Project Alternative. Increased access and consequent increased harvest of coldwater fish species with no corresponding changes to current regulations could negatively affect coldwater species within the project area.

C4.3.3 Summary of Potential Effects on Coldwater Reservoir Fisheries

Implementation of the Proposed Project during the initial new license operating period is not expected to affect the quality or quantity of coldwater fish habitat available in Oroville Facilities reservoirs relative to the No-Project Alternative.

Potential coldwater fisheries reservoir resource effects associated with the implementation of any future facilities modifications and the potential development of new water temperature requirements at the hatchery, Table 1 targets at Robinson Riffle and Table 2 targets at the lower Project Boundary would be evaluated in a subsequent environmental document prior to their construction.

C4.4 LOWER FEATHER RIVER FISH SPECIES

The overall determination of effects on each species of primary management concern in the lower Feather River with implementation of the Proposed Project incorporates all of the types of effects associated with each project measure included in the alternative for each life stage of the species. Qualitative analyses were performed on various potential effects resulting from implementation of the Proposed Project to determine the incremental effects associated with each project measure included in the alternative. The results of the effects analysis of each project measure on each life stage were synthesized to determine the overall effects of the Proposed Project on the species. As needed, subsequent environmental documentation and evaluation of potential project effects would be developed to address additional details and implementation plans of actions prior to their implementation.

C4.4.1 Fall-run Chinook Salmon

C4.4.1.1 Flow-Related Effects

Adult Immigration and Holding

Increases in flows from 600 cfs to 700 cfs from April 1 through September 14 and to 800 cfs from September 15 through March 31 in the LFC during the initial new license operating period under the Proposed Project could potentially have a beneficial effect on immigrating and holding fall-run Chinook salmon by increasing the lower Feather River stage elevation over potential critical riffles. Although stage increases would be small, shallow riffles could potentially become deeper, reducing the effort required by immigrating adult fall-run Chinook salmon to proceed through shallow riffles. In addition, water depth would be increased, creating additional amounts of suitable holding habitat.

No net changes in flows relative to the No-Project Alternative are expected in the HFC with implementation of the Proposed Project. Flow fluctuations that could potentially occur in the HFC under the Proposed Project likely would be similar to flow fluctuations that would occur under the No-Project Alternative. Because flow fluctuations currently do not affect fall-run Chinook salmon adult immigration and holding, flow fluctuations

under the Proposed Project would not affect fall-run Chinook salmon adult immigration and holding.

Adult Spawning and Embryo Incubation

Under the Proposed Project, flows in the LFC would be 800 cfs during the adult spawning and embryo incubation life stage. Flow fluctuations in the LFC could potentially occur under the Proposed Project to meet water temperature objectives prescribed to protect fisheries resources.

Increased flow releases to meet water temperature objectives during September during the initial new license operating period could potentially affect fall-run Chinook salmon spawning and embryo incubation by causing redd dewatering, which could occur as flows return to normal after water temperature objectives are met. Because increasing flows to meet water temperature objectives increases river stage, spawning individuals could potentially construct redds in areas that could be dewatered as flows are lowered to normal levels (800 cfs). However, based on available stage-discharge relationships and Chinook salmon redd water depth distribution from the SP-F16 report (see Section G-AQUA1.10 of Appendix G-AQUA1, Affected Environment, of the PDEA), the first redds would not be dewatered until there was more than a 0.4-foot change in stage elevation. Water temperature control flow changes are at or less than 200 cfs, and from 800 cfs to 1,000 cfs all of the spawning riffle stage elevations are anticipated to change less than 0.4 foot. The shallowest redd depth reportedly observed in the lower Feather River is 0.7 foot (DWR 2003). This analysis indicates that no redds would be dewatered in water temperature control-related flow changes in the LFC.

Evaluation of the Weighted Usable Area (WUA) index generated by the physical habitat simulation (PHABSIM) model for the adult spawning life stage of Chinook salmon (spring-run and fall-run) indicated that the maximum amount of spawning area in the LFC, given the current channel configuration, would occur at flows from 800 to 825 cfs (DWR 2004). Figure C4.4-1 shows the WUA curve generated by the PHABSIM model for Chinook salmon spawning in the LFC.

Flows in the LFC during the Chinook salmon spawning period would be 600 cfs under the No-Project Alternative, resulting in approximately 91 percent of maximum WUA. Flows in the LFC during the Chinook salmon spawning period would be 800 cfs under the Proposed Project which would result in almost 100 percent of maximum WUA, representing an increase in the quantity of available spawning habitat compared to the No-Project Alternative.

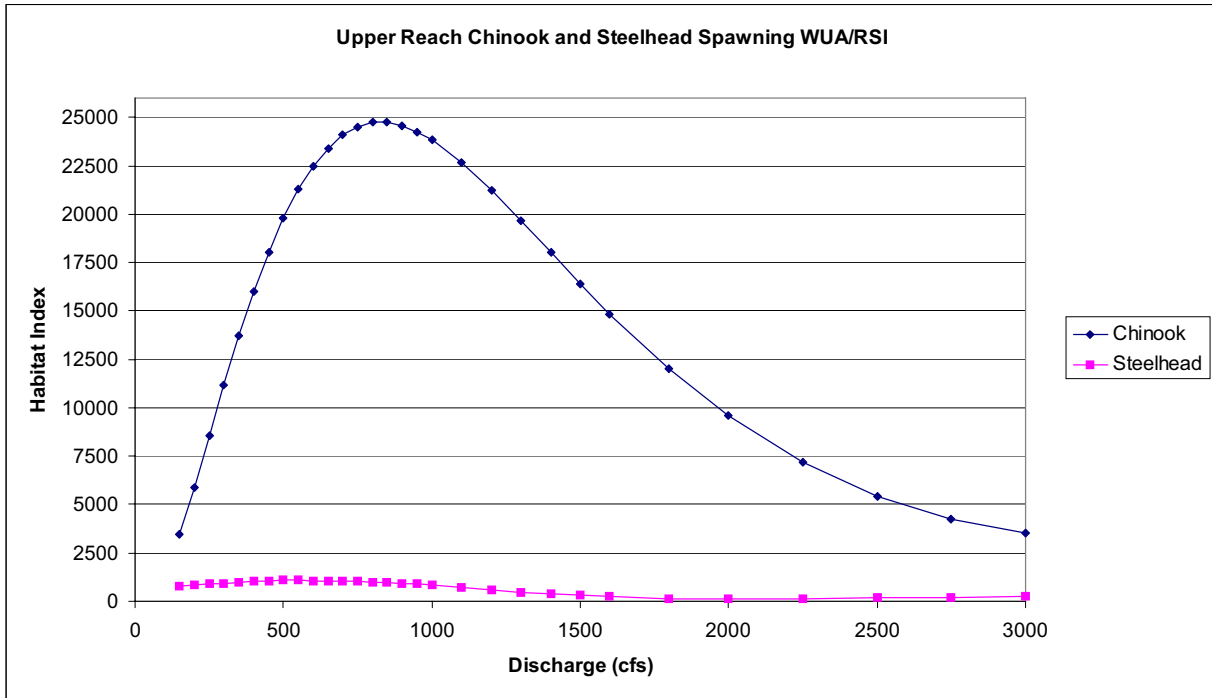


Figure C4.4-1. Low Flow Channel WUA curves for Chinook salmon.

Under the Proposed Project, flows and flow fluctuations occurring in the HFC are not expected to differ from flows or flow fluctuations that would occur under the No-Project Alternative as described in Section 5.2.1, Surface Water Quantity. Because there would be no changes in flows or flow fluctuations in the HFC with implementation of the Proposed Project compared to the No-Project Alternative, the Proposed Project would not result in a change in the amount of spawning habitat available for fall-run Chinook salmon or in rates of redd dewatering occurring in the HFC.

Juvenile Rearing and Downstream Movement

Increased flows in the LFC under the Proposed Project, relative to the No-Project Alternative would increase river stage slightly and could potentially increase available rearing habitat for juvenile salmonids, including fall-run Chinook salmon. However, the increase in river stage associated with a 100-cfs to 200-cfs increase in flow likely would be insufficient to appreciably increase rearing habitat availability. Therefore, increased flows would have no affect on fall-run Chinook salmon juvenile rearing and downstream movement.

Flow fluctuations in the LFC could potentially occur under the Proposed Project to meet new water temperature objectives prescribed to protect fisheries resources. Flow fluctuations could result in juvenile salmonid stranding in isolation ponds or beach stranding. However, isolation ponds do not occur in the LFC below 1,200 cfs; therefore, no isolation pond-related stranding is anticipated with implementation of the Proposed Project. Beach stranding could occur with changes in water surface elevation from changes in flows. Juvenile salmonids tend to select deeper water with increased size

and become less susceptible to beach-type stranding as they grow. Although flow increases of up to 1,500 cfs would be allowed for under the Proposed Project, typically flow fluctuations for water temperature control in the LFC during the summer are 200 cfs or less. A large portion of the juvenile fall-run Chinook salmon population emigrates from the Feather River system before May and therefore would not be subjected to potential beach stranding from flow fluctuations associated with implementation of the Proposed Project. Those juvenile fall-run Chinook salmon with prolonged rearing periods would be larger and have deeper water depth preferences before May; therefore they are less susceptible to beach stranding from flow fluctuations. However, some beach stranding could occur due to flow fluctuations occurring under the Proposed Project. Because water temperature control–related flow changes typically are 200 cfs or less and occur in the summer when rearing juveniles are larger and have preference for deeper water, rearing juvenile fall-run Chinook salmon would not be susceptible to beach stranding resulting from water temperature control–related flow changes.

Implementation of the Proposed Project would not result in any change in the frequency or magnitude of flow fluctuations in the HFC compared to the No-Project Alternative; therefore, no change in the rate of stranding by juvenile fall-run Chinook salmon would occur in the HFC.

C4.4.1.2 Water Temperature–Related Effects

The analysis of water temperature–related effects is qualitative and based on increased flows in the LFC during the initial new license operating period as proposed in the Proposed Project, relative to the No-Project Alternative. Increased flows would result in cooler water temperatures in the LFC during most of the year. Additionally, because the LFC would be contributing a higher proportion of overall flow in the lower Feather River, decreases in water temperature are anticipated to extend downstream of the Thermalito Afterbay Outlet.

The California Central Valley Chinook salmon population is at the extreme southern limit of the species range. Water temperature regimes experienced by these populations are different than those experienced by more northern populations. Low water temperatures are rarely a concern in the Sacramento River system. However, warm water temperatures are a critical management issue. Therefore, in general, actions that reduce water temperatures are considered beneficial to all races of Central Valley Chinook salmon.

Adult Immigration and Holding

As a result of increased flows in the LFC, water temperatures in the lower Feather River would be cooler under the Proposed Project, relative to the No-Project Alternative. Cooler water temperature–related effects on the adult immigration and holding life stage of Chinook salmon would range from insignificant to slightly beneficial. Cooler water extending downstream of the Thermalito Afterbay Outlet also would have an insignificant to slightly beneficial effect on this life stage.

Adult Spawning and Embryo Incubation

Most Chinook salmon spawning in the Feather River occurs in the LFC. With implementation of the Proposed Project, water temperatures are expected to generally decrease relative to temperatures under the No-Project Alternative. Therefore, implementation of the Proposed Project would likely be beneficial to Chinook salmon spawning and embryo incubation. Additionally, because cooler water temperatures would persist downstream into the HFC, additional suitable spawning habitat may become available for Chinook salmon spawning.

Juvenile Rearing and Downstream Movement

Unlike spring-run Chinook salmon, which may rear year-round in the lower Feather River, fall-run Chinook salmon begin their outward migration shortly after emergence and may occur as early as November. Most fall-run Chinook salmon reportedly have emigrated from the Feather River by June. Therefore, effects of cooler water temperatures during the fall-run Chinook salmon juvenile rearing and downstream movement life stage period in the lower Feather River resulting from implementation of the Proposed Project likely would be insignificant.

C4.4.1.3 Predation-Related Effects

Changes in minimum flows in the LFC associated with implementation of the Proposed Project are not expected to change the nature or rate of predation on fall-run Chinook salmon relative to the No-Project Alternative. Water temperature changes would be small and are not expected to change the distribution, species composition, consumption rates, or nature of predation in the lower Feather River. Changes in hatchery-produced steelhead release practices may reduce predation on naturally produced juvenile fall-run Chinook salmon. The LWD supplementation and improvement program would improve juvenile Chinook salmon rearing cover conditions, resulting in an overall reduction of predation rates on juvenile fall-run Chinook salmon.

C4.4.1.4 Fisheries Management-Related Effects

Hatchery

A hatchery adaptive management program (SA Article A107.2) included in the Proposed Project considers a range of potential changes in Feather River Fish Hatchery practices designed to reduce adverse effects of the hatchery on wild fish stocks and to improve the benefits to the Chinook salmon produced by the hatchery. Changes in hatchery practices intended to more successfully identify and true-breed spring-run and fall-run Chinook salmon would reduce the amount of genetic introgression between these two runs that may have previously occurred in the hatchery. Other potential adaptive management elements may include changes in steelhead size at release and timing of release to reduce potential steelhead predation on juvenile Chinook salmon. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to alter rearing fish conditioning to improve predator

avoidance and cover use upon release. An enhanced fish marking program included as one of the potential actions in the adaptive management portion of the program would improve the ability to measure hatchery performance and increase the understanding of the fisheries resources in the lower Feather River. The hatchery program also includes the development of Hatchery Genetic Management Plans (HGMPs) for each of the anadromous fish species managed by the hatchery.

Disease

Water temperature changes during the initial new license operating period of the Proposed Project would be relatively small; therefore, no changes in water temperature–related interactions with the incidence of fish diseases are anticipated. The potential hatchery water treatment action associated with the hatchery improvement program could reduce the incidence and severity of disease in the Feather River Fish Hatchery, which would lower overall disease pressure in the lower Feather River.

Fishing Regulations, Poaching, and Change in Recreational Access and Visitation

Recreation enhancements included in the Proposed Project are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access in the lower Feather River is anticipated to increase with the implementation of the Proposed Project through the implementation of recreation enhancements (e.g., construction of a paved trail from the fish hatchery downstream to the lower Project Boundary) included in the Proposed Project. See Section 5.7.4 for additional information on recreation enhancements.

Installation of fish segregation weirs in the Lower Feather River would require no-fishing zones in the immediate proximity of the installations. Although the weirs would be navigable by boats, the presence of the weirs may affect boating recreation activities to some degree. See Section 5.7.4 for additional information about effects of fish segregation weirs on recreation. Increased densities of fish below the weirs and river access on the weirs may potentially contribute to fish poaching opportunities with implementation of the Proposed Project.

C4.4.1.5 Summary of Potential Effects on Fall-run Chinook Salmon

Study plan report summaries addressing project effects on fall-run Chinook salmon are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; Section G-AQUA1.5, Fisheries Management; Section G-AQUA1.8, Salmonids and Their Habitat in the Feather River Below the Fish Barrier Dam; and Section G-AQUA1.11, Predation, in Appendix G-AQUA1 of the PDEA. A description of each life stage for fall-run Chinook salmon and the time period associated with it is presented in Appendix G-AQUA1 of the PDEA.

Adult Immigration and Holding

Actions during the initial new license operating period potentially affecting fall-run Chinook salmon adult immigration and holding include changes to instream flows and water temperatures in the LFC, a hatchery adaptive management program, fish segregation weirs, and LWD supplementation.

Increased stream flows of 700 cfs to 800 cfs in the LFC under the Proposed Project could potentially benefit immigrating fall-run Chinook salmon by increasing lower Feather River stage elevations. Although stage increases would be small, shallow riffles could potentially become deeper, reducing the effort required by immigrating fall-run Chinook salmon to proceed through shallow riffles. Additionally, increasing flows would slightly reduce average daily water temperatures, thereby increasing overall habitat suitability during the immigration and holding period.

The hatchery adaptive management program would potentially have a beneficial effect on immigrating adult fall-run Chinook salmon by allowing more accurate identification of returning Feather River Fish Hatchery fish and by increasing genetic isolation between runs, thereby potentially reducing effects on phenotypic separation with respect to immigration timing.

Installation of fish segregation weirs would have a beneficial effect on fall-run Chinook salmon immigration by eliminating fishing pressure in the no-fishing zones in the vicinity of the weirs. It would also increase genetic segregation of runs by spatially segregating holding adult spring-run Chinook salmon from immigrating fall-run Chinook salmon. However, the potential for increased poaching of fall-run Chinook salmon in the vicinity of the fish segregation weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those locations.

LWD supplementation would have a beneficial effect on immigrating adult fall-run Chinook salmon by creating potential velocity refuges.

Overall, implementation of the Proposed Project would result in a beneficial effect on fall-run Chinook salmon adult immigration and holding relative to the No-Project Alternative.

Spawning and Embryo Incubation

Actions potentially affecting fall-run Chinook salmon adult spawning and embryo incubation include changes to instream flows and water temperatures in the LFC, a hatchery adaptive management program, fish segregation weirs, gravel supplementation and creation and enhancement of additional side-channel habitat.

An increase in instream flows in the LFC from 600 cfs to 800 cfs during the initial new license operating period during the adult spawning and embryo incubation period would increase WUA from 91 percent of maximum to almost 100 percent. Reduced average

daily water temperatures, under the Proposed Project, result in increased overall habitat suitability for fall-run Chinook salmon adult spawning and embryo incubation.

The hatchery adaptive management program would potentially have a beneficial effect on this life stage by reducing genetic introgression between spring- and fall-run Chinook salmon. The water treatment action associated with the hatchery management adaptive management program under the Proposed Project would potentially have an additional beneficial effect on incubation fall-run Chinook salmon embryos by minimizing the potential for disease-associated embryonic mortality in the Feather River Fish Hatchery and by reducing the accumulated disease pressure in the lower Feather River.

Installation of fish segregation weirs in the lower Feather River likely would benefit fall-run Chinook salmon adult spawning and embryo incubation by maintaining spatial segregation of spawning spring-run and fall-run Chinook salmon, and by eliminating fishing pressure on fish spawning in the no-fishing zones in the vicinity of the weirs. However, the potential for poaching fall-run Chinook salmon in the vicinity of the fish segregation weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those areas.

Gravel supplementation would benefit fall-run Chinook salmon adult spawning and embryo incubation by increasing the quantity and quality of available spawning habitat, thereby reducing competition for available habitat and resulting pre-spawn mortality rates as well as reducing redd superimposition and resulting egg mortality. Likewise, creation and enhancement of side-channel habitat under the Proposed Project would benefit fall-run Chinook salmon spawning and embryo incubation by increasing overall habitat availability.

Overall, implementation of the Proposed Project would result in a beneficial effect on fall-run Chinook salmon adult spawning and embryo incubation relative to the No-Project Alternative.

Juvenile Rearing and Downstream Movement

Actions potentially affecting fall-run Chinook salmon juvenile rearing and downstream movement include changes to instream flows in the LFC, a hatchery adaptive management program, gravel supplementation, LWD supplementation and creation, and enhancement of side-channel habitat.

Flow fluctuations could occur in the LFC during the summer during the initial new license operating period to meet water temperature requirements to protect fisheries resources. This could result in an adverse effect on fall-run Chinook salmon juvenile rearing and downstream movement by increasing the potential for beach stranding. However, based on the SP-G2 analysis indicating that isolation ponds do not form below 1,200 cfs, the emigration timing of most juvenile Chinook salmon in the Feather River, and on the preference for increased water depths as rearing juveniles grow larger later in the rearing season, it is unlikely that any substantial change in the rate of beach stranding would occur as a result of flow fluctuations in the LFC. Although flow

increases of up to 1,500 cfs would be allowed for under the Proposed Project, typically flow fluctuations for water temperature control in the LFC during the summer are 200 cfs or less.

The hatchery adaptive management program would potentially have a beneficial effect on this life stage by improving genetic segregation between spring- and fall-run Chinook salmon. Additionally, by potentially altering the size at release and timing of release of juvenile steelhead into the lower Feather River, the hatchery adaptive management program could reduce predation rates on rearing and emigrating fall-run Chinook salmon. By altering raceways at the Feather River Fish Hatchery, the hatchery adaptive management program could increase post-release survival rates of juvenile fall-run Chinook salmon.

Gravel enhancement and LWD supplementation would potentially have a beneficial effect on rearing and downstream migrating fall-run Chinook salmon by increasing channel complexity and the amount and quality of rearing habitat. However, placement of LWD could potentially have an adverse effect by increasing warmwater predator habitat.

Creation and enhancement of side-channel habitat under the Proposed Project would increase the amount of juvenile rearing habitat compared to the No-Project Alternative.

Overall, implementation of the Proposed Project would result in a beneficial effect on fall-run Chinook salmon juvenile rearing and downstream movement relative to the No-Project Alternative.

C4.4.1.6 Potential Facility Modifications

Although it is not possible to quantify the effects of facility modifications on fall-run Chinook salmon with currently available information, each of the potential future facility modifications being studied would likely benefit fall-run Chinook salmon through increased quantity and quality of habitat with suitable water temperature conditions. A qualitative evaluation of the potential effects of future facilities modifications on lower Feather River aquatic habitat is described in Section C4.1.7 above.

Conclusion

Based on the above summary of potential effects, the Proposed Project would result in an overall beneficial effect on fall-run Chinook salmon relative to the No-Project Alternative.

C4.4.2 Spring-run Chinook Salmon

C4.4.2.1 Flow-Related Effects

Adult Immigration and Holding

An increased instream flow of 700 cfs to 800 cfs in the LFC during the initial new license operating period under the Proposed Project, relative to the No-Project Alternative, could potentially have a beneficial effect on immigrating and holding spring-run Chinook salmon by increasing the lower Feather River stage elevation over potential critical riffles. Although stage increases would be small, shallow riffles could potentially become deeper, reducing effort required by immigrating adult spring-run Chinook salmon to proceed through shallow riffles. In addition, water depth would be increased, creating additional amounts of suitable holding habitat.

No flow changes, relative to the No-Project Alternative, are expected in the HFC with implementation of the Proposed Project.

Adult Spawning and Embryo Incubation

Flow changes in the LFC included in the Proposed Project would affect spring-run Chinook salmon adult spawning and embryo incubation in the same way that they would affect this life stage for fall-run Chinook salmon. Refer to the above discussion of potential flow-related effects on fall-run Chinook salmon adult spawning and embryo incubation for the evaluation of flow-related effects on spring-run Chinook salmon adult spawning and embryo incubation.

Juvenile Rearing and Downstream Movement

The early and peak juvenile rearing and downstream movement periods are the same for spring-run Chinook salmon as for fall-run Chinook salmon. However, spring-run Chinook salmon can rear in the lower Feather River year round (i.e., after fall-run Chinook salmon have emigrated). Flow changes in the LFC included in the Proposed Project would affect the early portion of the juvenile rearing and downstream movement period for spring-run Chinook salmon in the same way that they would affect this life stage for fall-run Chinook salmon. The above discussion of fall-run Chinook salmon juvenile rearing and downstream movement provides an evaluation of flow-related effects on spring-run Chinook salmon juvenile rearing and downstream movement during the early portion of this period. Flow fluctuations occurring during the later periods of extended spring-run Chinook salmon juvenile rearing after fall-run Chinook salmon have emigrated are not expected to cause stranding because larger juveniles are not susceptible to any additional stranding type losses associated with implementation of the Proposed Project because larger juveniles display a preference for deeper water habitat.

C4.4.2.2 Water Temperature–Related Effects

The analysis of water temperature–related effects is qualitative and based on increased flows in the LFC under the Proposed Project relative to the No-Project Alternative. Increased flows would result in cooler water temperatures in the LFC during most of the year. Additionally, because the LFC would be contributing a larger proportion of overall flow in the lower Feather River, decreases in water temperature are anticipated to extend downstream of the Thermalito Afterbay Outlet.

Adult Immigration and Holding

Increased flows in the LFC would result in cooler water temperatures in the lower Feather River under the Proposed Project, relative to the No-Project Alternative. Cooler water temperature effects on the adult immigration and holding life stage of Chinook salmon would range from insignificant to slightly beneficial. Cooler water temperatures extending downstream of the Thermalito Afterbay Outlet also would have an insignificant to slightly beneficial effect on this life stage.

Adult Spawning and Embryo Incubation

The spring-run Chinook salmon adult spawning and embryo incubation life stage has the same life stage periodicity and water temperature requirements as those of fall-run Chinook salmon. The above discussion of water temperature–related effects on fall-run Chinook salmon adult spawning and embryo incubation describes potential water temperature effects of the Proposed Project on spring-run Chinook salmon adult spawning and embryo incubation.

Juvenile Rearing and Downstream Movement

The early and peak juvenile rearing and downstream movement periods are the same for spring-run Chinook salmon as for fall-run Chinook salmon. However, spring-run Chinook salmon can rear in the lower Feather River year round (i.e., after fall-run Chinook salmon have emigrated). While effects of cooler water temperatures for this life stage of fall-run Chinook salmon are expected to be insignificant, cooler water temperatures in the lower Feather River associated with implementation of the Proposed Project likely would be beneficial to this life stage for spring-run Chinook salmon because rearing occurs through the summer months.

C4.4.2.3 Predation-Related Effects

Changes in minimum flows in the LFC during the initial new license operating period resulting from implementation of the Proposed Project are not expected to change the nature or rate of predation on spring-run Chinook salmon. Water temperature changes would be very small and are not expected to change the distribution, species composition, consumption rates, or nature of predation in the lower Feather River. Adaptive management changes in steelhead hatchery release practices may reduce hatchery-produced steelhead predation on juvenile spring-run Chinook salmon. The

LWD supplementation and improvement program would improve juvenile rearing cover conditions and may result in a reduction of predation rates on juvenile spring-run Chinook salmon. However, placement of LWD in some areas of the river could potentially increase warmwater predator habitat availability downstream of the Thermalito Afterbay Outlet.

C4.4.2.4 Fisheries Management–Related Effects

Hatchery

A hatchery adaptive management program included in the Proposed Project considers a range of potential changes in hatchery practices designed to reduce adverse effects of the Feather River Fish Hatchery on wild fish stocks and improve the benefits to the Chinook salmon produced by the hatchery. Changes in hatchery practices intended to more successfully identify true-breed spring-run and fall-run Chinook salmon would reduce the amount of genetic introgression between these two runs that may have previously occurred in the hatchery. Other potential adaptive management elements may include changes in steelhead size at release and timing of release to reduce potential steelhead predation on juvenile Chinook salmon. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to alter rearing fish conditioning to improve predator avoidance and cover use upon release. An enhanced fish marking program included as one of the potential actions in the adaptive management portion of the program would improve the ability to measure hatchery performance and increase the understanding of the fisheries resources in the lower Feather River. The hatchery program also includes the development of HGMPs for each of the anadromous fish species managed by the hatchery.

Disease

Water temperature changes associated with implementation of the Proposed Project would be relatively small; therefore, no changes in water temperature–related incidence of fish disease are anticipated. The proposed hatchery water treatment action associated with the hatchery improvement program could reduce the rate of incidence and severity of disease occurrences in the Feather River Fish Hatchery, which, as a result, would lower overall fish disease pressure in the lower Feather River.

Fishing Regulations, Poaching, and Change in Recreational Access and Visitation

Recreation enhancements included in the Proposed Project are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access in the lower Feather River is anticipated to increase with the implementation of the Proposed Project through the installation of fish segregation weirs and other recreation enhancements included in the Proposed Project. See Section 5.7.4 for additional information on recreation enhancements.

Installation of fish segregation weirs in the Lower Feather River would require no-fishing zones in the immediate proximity of the installations. Although the weirs would be navigable by boats, the presence of the weirs may affect boating recreation activities to

some degree. See Section 5.7.4 for additional information on fish segregation weir effects on recreation. Increased densities of fish below the weirs and river access on the weirs could potentially contribute to fish poaching opportunities with implementation of the Proposed Project.

C4.4.2.5 Summary of Potential Effects on Spring-run Chinook Salmon

Study plan report summaries addressing project effects on spring-run Chinook salmon are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; Section G-AQUA1.5, Fisheries Management; Section G-AQUA1.8, Salmonids and Their Habitat in the Feather River Below the Fish Barrier Dam; and Section G-AQUA1.11, Predation, in Appendix G-AQUA1 of the PDEA. A description of each spring-run Chinook salmon life stage and the time period associated with it is presented in Appendix G-AQUA1 of the PDEA.

Adult Immigration and Holding

Actions potentially affecting spring-run Chinook salmon adult immigration and holding include changes to instream flows and water temperatures in the LFC, a hatchery adaptive management program, fish segregation weirs, and LWD supplementation.

Increased stream flows of 700 cfs to 800 cfs in the LFC during the initial new license operating period under the Proposed Project could potentially benefit immigrating spring-run Chinook salmon by increasing lower Feather River stage elevations. Although stage increases would be small, shallow riffles could potentially become deeper, reducing the effort required by immigrating spring-run Chinook salmon to proceed through shallow riffles. Additionally, increasing flows would slightly reduce average daily water temperatures, thereby increasing overall habitat suitability during the immigration and holding period.

The hatchery adaptive management program potentially would provide a beneficial effect by allowing more accurate identification of returning hatchery fish and by increasing genetic isolation between runs, thereby improving phenotypic separation between runs with respect to immigration timing.

Installation of fish segregation weirs would have a beneficial effect on spring-run Chinook salmon adult immigration and holding by eliminating fishing pressure within the no-fishing zones in the vicinity of the weirs, and by increasing genetic segregation between runs by spatially segregating holding adult spring-run Chinook salmon from immigrating fall-run Chinook salmon. However, the potential for poaching spring-run Chinook salmon in the vicinity of the fish segregation weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those locations.

LWD supplementation upstream of the fish segregation weirs would have a beneficial effect on this life stage by creating potential velocity refuges for holding adult spring-run Chinook salmon.

Overall, implementation of the Proposed Project would result in a beneficial effect on spring-run Chinook salmon adult immigration and holding relative to the No-Project Alternative.

Adult Spawning and Embryo Incubation

Actions potentially affecting spring-run Chinook salmon adult spawning and embryo incubation include changes to instream flows and water temperatures in the LFC, a hatchery adaptive management program, fish segregation weirs, side-channel habitat enhancement, and gravel supplementation.

An increase in instream flows in the LFC from 600 cfs to 800 cfs during the adult spawning and embryo incubation period would increase WUA from 91 percent of maximum to almost 100 percent. Reduced average daily water temperatures under the Proposed Action would result in increased overall habitat suitability for spring-run Chinook salmon adult spawning and embryo incubation.

The hatchery adaptive management program would potentially provide a beneficial effect by reducing the rate of genetic introgression between spring- and fall-run Chinook salmon.

Installation of fish segregation weirs in the lower Feather River likely would benefit spring-run Chinook salmon adult spawning and embryo incubation by maintaining spatial segregation of spawning spring-run and fall-run Chinook salmon, and by eliminating fishing pressure on fish spawning in the no-fishing zones in the vicinity of the weirs. Additionally, fish segregation weirs would provide a beneficial effect by reducing competition for spawning habitat, which would reduce redd superimposition, and thereby increase embryo survival. However, the potential for poaching spring-run Chinook salmon in the vicinity of the weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those areas.

Side-channel habitat enhancement and gravel supplementation could potentially benefit spring-run Chinook salmon adult spawning and embryo incubation by increasing the amount of available spawning habitat, thereby reducing competition for available habitat and reducing redd superimposition.

Overall, implementation of the Proposed Project would result in a beneficial effect on spring-run Chinook salmon adult spawning and embryo incubation relative to the No-Project Alternative.

Juvenile Rearing and Downstream Movement

Actions potentially affecting spring-run Chinook salmon juvenile rearing and downstream movement include changes to instream flows and water temperatures in

the LFC, a hatchery adaptive management program, side-channel habitat enhancement, gravel supplementation, and LWD supplementation.

Flow fluctuations could occur in the LFC during the summer to meet water temperature requirements to protect fisheries resources. This could result in an adverse effect on spring-run Chinook salmon juvenile rearing and downstream movement by increasing the potential for beach stranding. However, based on the SP-G2 analysis indicating that isolation ponds do not form below 1,200 cfs, the emigration timing of most juvenile Chinook salmon in the Feather River, and on the preference for increased water depths as rearing juveniles grow larger later in the rearing season, it is unlikely that any substantial change in the rate of beach stranding would occur as a result of flow fluctuations in the LFC. Typically flow fluctuations for water temperature control in the LFC during the summer are 200 cfs or less. Additionally, increasing flows would slightly reduce average daily water temperatures, thereby increasing overall habitat suitability during the summer months when some spring-run Chinook salmon could be rearing in the river.

The hatchery adaptive management program would potentially have a beneficial effect on this life stage by increasing genetic segregation between spring- and fall-run Chinook salmon. Additionally, by potentially altering the size at release and timing of juvenile steelhead releases into the lower Feather River, the hatchery adaptive management program could reduce predation on rearing and emigrating juvenile spring-run Chinook salmon. By altering raceways at the Feather River Fish Hatchery, the hatchery adaptive management program could increase post-release survival rates of juvenile spring-run Chinook salmon.

Side-channel habitat enhancement, gravel enhancement, and LWD supplementation would potentially have a beneficial effect on rearing and downstream migrating spring-run Chinook salmon by increasing channel complexity and increasing the amount and quality of rearing habitat. However, placement of LWD could potentially have an adverse effect by increasing warmwater predator habitat availability downstream of the Thermalito Afterbay Outlet.

Overall, implementation of the Proposed Project would result in a beneficial effect on spring-run Chinook salmon juvenile rearing and downstream movement relative to the No-Project Alternative.

C4.4.2.6 Potential Facility Modifications

Although it is not possible to quantify the effects of facility modifications on spring-run Chinook salmon with the information available at this time, each of the potential future facility modifications being studied would benefit spring-run Chinook salmon through increased quantity and quality of habitat with suitable water temperature conditions. A qualitative evaluation of the potential effects of future facilities modifications on lower Feather River aquatic habitat is described in Section C4.1.7 above.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Project would result in an overall beneficial effect on spring-run Chinook salmon relative to the No-Project Alternative.

C4.4.3 Steelhead

C4.4.3.1 Flow-Related Effects

Adult Immigration and Holding

Flow in the HFC would not change with implementation of the Proposed Project, relative to the No-Project Alternative; therefore, there would be no flow-related effects on steelhead adult immigration and holding in the HFC. Water depths in the LFC would be increased slightly with implementation of the Proposed Project, which would be slightly beneficial to steelhead adult immigration and holding because of the increase in the amount of habitat that would meet minimum water depth requirements. Increased flows in the LFC from May through August would have no effect on steelhead adult immigration and holding because the adult immigration and holding period for adult steelhead migrating to the Feather River begins during September.

Adult Spawning and Embryo Incubation

Under the Proposed Project, flows in the LFC would be 800 cfs during most of the adult steelhead spawning and embryo incubation period. Flow fluctuations in the LFC for water temperature control during the summer, could potentially occur with implementation of the Proposed Project. However, this time period is outside the time period for most steelhead spawning and embryo incubation.

No water temperature management flow increases above 800 cfs would occur before the end of steelhead spawning; therefore, there would be no risk of establishing redds at stage elevations that could potentially be dewatered by a subsequent LFC flow fluctuations.

Implementation of the Proposed Project would not result in any change in the frequency or magnitude of flow fluctuations in the HFC, relative to the No-Project Alternative; therefore, there would be no change in the rate of steelhead redd dewatering occurring in the HFC with implementation of the Proposed Project.

Evaluation of the WUA index generated by the PHABSIM model for the steelhead adult spawning life stage indicates the maximum amount of spawning area in the LFC, given the current channel configuration, occurs at flows around 500 cfs. However, no distinct maximum occurs over the range of flow between 150 cfs and 1,500 cfs (DWR 2004). Figure C4.4-2 shows the steelhead spawning WUA curve (lower) generated by the PHABSIM model for the LFC.

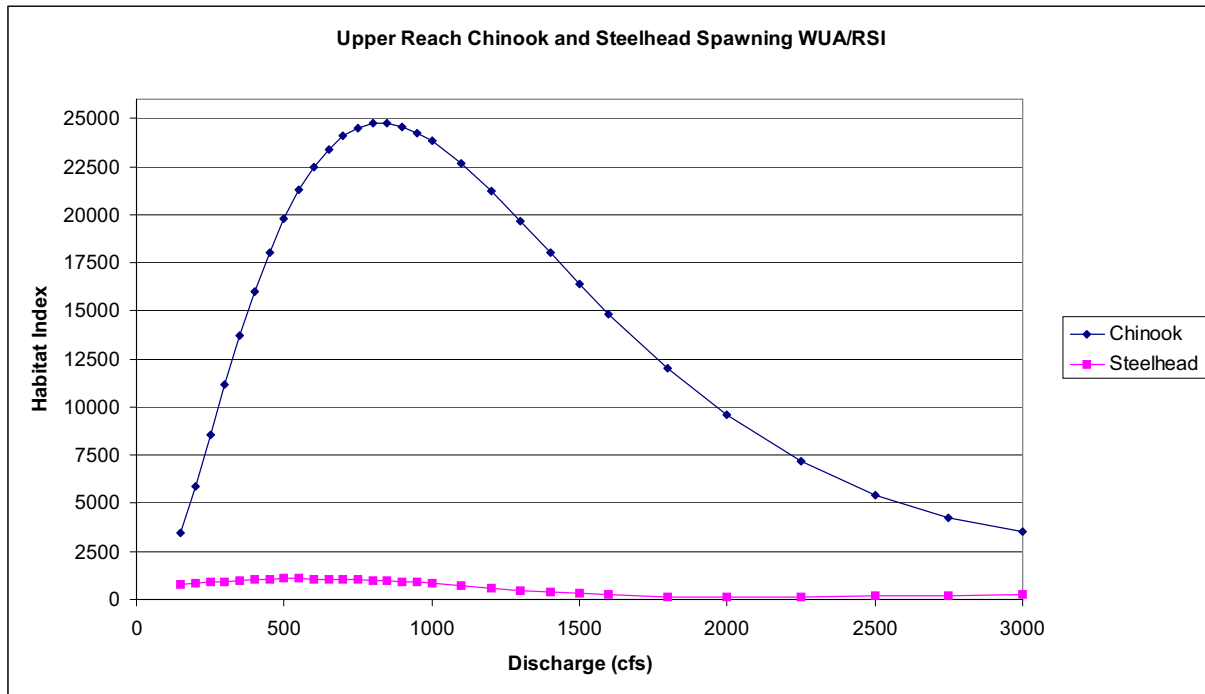


Figure C4.4-2. Low Flow Channel WUA curves for steelhead.

Under the No-Project Alternative, flows in the LFC during the steelhead spawning period would be 600 cfs, which would result in approximately 98 percent of maximum WUA. Flows in the LFC under the Proposed Project would be 800 cfs during the steelhead spawning period, which would result in approximately 91 percent of maximum WUA, representing a small decrease in WUA compared to the No-Project Alternative.

Under the Proposed Project, flows and flow fluctuations occurring in the HFC are not expected to differ from those occurring under the No-Project Alternative (described in Section 5.2, Surface Water). As a result, implementation of the Proposed Project would not result in a change in the amount of steelhead spawning habitat available or rates of redd dewatering occurring in the HFC.

Fry and Fingerling Rearing and Downstream Movement

Flow fluctuations in the LFC could potentially occur under the Proposed Project to meet water temperature objectives prescribed to protect fisheries resources. Flow fluctuations can result in juvenile salmonid isolation pond or beach stranding. Isolation ponds do not occur in the LFC below 1,200 cfs; therefore, no isolation pond stranding would be anticipated with implementation of the Proposed Project. Beach stranding can occur due to changes in water surface elevation associated with changes in flows. Juvenile steelhead tend to select deeper water with increased size, and therefore become less susceptible to beach-type stranding as they grow (i.e., later in the juvenile rearing period). Flow fluctuations of typically 200 cfs or less could occur during the summer as a result of temperature control actions. Water temperature control-related flow changes are typically 200 cfs or less and occur when rearing juveniles are larger

and have preference for deeper water, and therefore are not susceptible to beach-type stranding from water temperature control–related flow changes.

Implementation of the Proposed Project would not result in any change in the frequency or magnitude of flow fluctuations in the HFC compared to the No-Project Alternative; therefore, there would be no change in the rate of juvenile steelhead stranding occurring in the HFC.

Smolt Emigration

Changes in LFC flows with implementation of the Proposed Project are not expected to affect the quality or quantity of habitat for steelhead smolt emigration or the timing behavior of smolt emigration because emigrating smolts spend little time foraging and rearing and the majority of time actively migrating seaward.

C4.4.3.2 Temperature-Related Effects

The analysis of water temperature–related effects is qualitative and based on increased flows in the LFC as proposed under the Proposed Project, relative to the No-Project Alternative. Increased flows would result in cooler water temperatures in the LFC during most of the year. Additionally, because the LFC would be contributing a higher proportion of the overall flow in the lower Feather River, decreases in water temperature are anticipated to extend downstream of the Thermalito Afterbay Outlet.

The California Central Valley steelhead population is near the southern limit of the species range. Water temperature regimes experienced by these populations are different than those experienced by more northern populations. Low water temperatures rarely are a concern in the Sacramento River system. However, warm water temperatures are a critical management issue. Therefore, in general, actions that reduce water temperatures are considered beneficial to steelhead populations.

Adult Immigration and Holding

Because of increased flows in the LFC, water temperatures in the lower Feather River would be cooler under the Proposed Project relative to the No-Project Alternative. Because most steelhead adult immigration and holding occurs during the winter months, cooler water temperatures likely would not substantially affect steelhead adult immigration and holding.

Adult Spawning and Embryo Incubation

Most steelhead spawning in the Feather River occurs in the LFC. With implementation of the Proposed Project, water temperatures are expected to decrease relative to the No-Project Alternative. Therefore, implementation of the Proposed Project would likely be beneficial to steelhead spawning. Additionally, because cooler water temperatures would persist downstream into the HFC, additional suitable steelhead spawning habitat may become available.

Fry and Fingerling Rearing and Downstream Movement

Steelhead fry and fingerling rearing takes place year round in the lower Feather River. Cooler water temperatures likely would be beneficial to fry and fingerling rearing while effects on downstream movement likely would not be substantial.

Smolt Emigration

Effects of cooler water temperatures during the steelhead smolt emigration life stage in the lower Feather River under the Proposed Project, relative to the No-Project Alternative, likely would not be substantial with implementation of the Proposed Project.

C4.4.3.3 Predation-Related Effects

Changes in minimum flows in the LFC during the initial new license operating period are not expected to change the nature or rate of predation with implementation of the Proposed Project. Water temperature changes would be small and would not be expected to change the distribution, species composition, consumption rates, or nature of predation in the lower Feather River. Adaptive management changes in steelhead hatchery release practices may reduce predation on juvenile wild steelhead. The LWD supplementation and improvement program would improve juvenile rearing cover conditions and may result in a reduction of predation rates on juvenile steelhead.

C4.4.3.4 Fisheries Management-Related Effects

Hatchery

A hatchery adaptive management program included in the Proposed Project considers a range of potential changes in hatchery practices designed to reduce adverse effects of the Feather River Fish Hatchery on wild fish stocks and improve the benefits to steelhead produced by the hatchery. These potential changes include changes in steelhead size at release and timing of release to reduce potential size advantages of hatchery steelhead over wild steelhead, as well as to reduce potential steelhead predation on wild juvenile steelhead. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to alter rearing fish conditioning to improve predator avoidance and increase cover use. An enhanced fish marking program included as an action in the adaptive management program would improve the ability to measure hatchery performance and increase the understanding of the fisheries resources in the lower Feather River. The hatchery program also includes the development of HGMPs for each of the anadromous fish species managed by the hatchery.

Disease

Water temperature changes associated with implementation of the Proposed Project would be relatively small; therefore, no changes in water temperature-related incidence of fish disease are anticipated. The proposed hatchery water treatment action could reduce incidence and severity of disease occurrences in the Feather River Fish

Hatchery, which, as a result, would lower overall fish disease pressure in the lower Feather River.

Fishing Regulations, Poaching, and Change in Recreational Access and Visitation

Recreation enhancements included in the Proposed Project are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access in the lower Feather River is anticipated to increase with the implementation of the Proposed Project associated with the installation of fish segregation weirs and other recreation enhancements included in the Proposed Project. See Section 5.7.4 for additional information on recreation enhancements.

Installation of fish segregation weirs in the lower Feather River would require no-fishing zones in the immediate proximity of the weirs. Although the fish segregation weirs would be navigable by boats, the presence of the weirs may affect boating recreation activities to some degree. See Section 5.7.4 for additional information on fish segregation weir effects on recreation. Increased densities of fish below the weirs and river access on the weirs could potentially contribute to fish poaching opportunities with implementation of the Proposed Project.

C4.4.3.5 Summary of Potential Effects on Steelhead

Study plan report summaries addressing project effects on steelhead are presented in Section G-AQUA1.5, Fisheries Management; Section G-AQUA1.8, Salmonids and Their Habitat in the Feather River Below the Fish Barrier Dam; and Section G-AQUA1.11, Predation, in Appendix G-AQUA1 of the PDEA. A description of each steelhead life stage and the time period associated with it is presented in Appendix G-AQUA1 of the PDEA.

Adult Immigration and Holding

Actions potentially affecting steelhead adult immigration and holding include changes to instream flows and water temperatures in the LFC, fish segregation weirs, and LWD supplementation.

Increased stream flows of 700 cfs to 800 cfs in the LFC under the Proposed Project could potentially benefit immigrating steelhead by increasing lower Feather River stage elevations. Although stage increases would be small, shallow riffles could potentially become deeper, reducing the effort required by immigrating steelhead to proceed through shallow riffles. Additionally, increasing flows would slightly reduce average daily water temperatures, thereby increasing overall habitat suitability during the immigration and holding period.

Installation of fish segregation weirs would have a beneficial effect on steelhead adult immigration and holding by eliminating fishing pressure within the no-fishing zones in the vicinity of the weirs. However, the potential for poaching of steelhead in the vicinity of the fish segregation weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those locations.

LWD supplementation upstream of the fish segregation weirs would have a beneficial effect on this life stage by creating potential velocity refuges and increased cover availability.

Overall, implementation of the Proposed Project would result in a beneficial effect on steelhead adult immigration and holding.

Adult Spawning and Embryo Incubation

Actions potentially affecting steelhead adult spawning and embryo incubation include installation of fish segregation weirs, side-channel habitat enhancement, and gravel supplementation.

Installation of fish segregation weirs in the lower Feather River likely would benefit steelhead adult spawning and embryo incubation by eliminating fishing pressure on fish spawning in the no-fishing zones in the vicinity of the weirs. However, the potential for increased poaching of steelhead in the vicinity of the fish segregation weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those areas.

Side-channel habitat enhancement and gravel supplementation could potentially benefit steelhead adult spawning and embryo incubation by increasing the quantity and quality of available spawning habitat, thereby reducing competition for available habitat. Additional habitat availability would result in reduced pre-spawn mortality rates as well as reduced redd superimposition and resulting egg mortality.

Overall, implementation of the Proposed Project would result in a beneficial effect on steelhead adult spawning and embryo incubation relative to the No-Project Alternative.

Fry and Fingerling Rearing and Downstream Movement

Actions potentially affecting steelhead fry and fingerling rearing and downstream movement include changes to instream flows and water temperatures in the LFC, a hatchery adaptive management program, side-channel habitat enhancement, gravel supplementation, and LWD supplementation.

Flow fluctuations could occur in the LFC during the summer to meet water temperature requirements to protect fisheries resources. This could result in an adverse effect on steelhead juvenile rearing and downstream movement by increasing the potential for beach stranding. However, based on the SP-G2 analysis indicating that isolation ponds do not form below 1,200 cfs, the emigration timing of most juvenile steelhead in the Feather River, and on the preference for increased water depths as rearing juveniles grow larger later in the rearing season, it is unlikely that any substantial change in the rate of beach stranding would occur as a result of flow fluctuations in the LFC. Additionally, increasing flows would slightly reduce average daily water temperatures, thereby increasing overall habitat suitability during the summer months when some steelhead could be rearing in the river.

The hatchery adaptive management program would potentially have a beneficial effect on this life stage by altering the size at release and timing of juvenile steelhead released into the lower Feather River, reducing predation on emigrating wild steelhead. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to improve rearing fish conditioning to improve predator avoidance and cover use.

Side-channel habitat enhancement, gravel enhancement, and LWD supplementation would have a beneficial effect on rearing and downstream migrating steelhead by increasing channel complexity and increasing the quantity and quality of rearing habitat. However, placement of LWD could potentially have an adverse effect by increasing warmwater predator habitat availability.

Overall, implementation of the Proposed Project would result in a beneficial effect on steelhead fry and fingerling rearing and downstream movement relative to the No-Action Alternative.

Smolt Emigration

Actions potentially affecting steelhead smolt emigration include a hatchery adaptive management program, side channel creation, and LWD supplementation. The hatchery adaptive management program would have a beneficial effect on this life stage by potentially altering the size at release and timing of juvenile steelhead released into the lower Feather River, which could reduce predation rates on emigrating wild steelhead smolts. Additionally, by altering raceways at the Feather River Fish Hatchery, the program could increase post-release survival rates of hatchery-produced steelhead smolts.

Creation of side channels provides additional foraging and refuge opportunities for emigrating smolts. LWD supplementation would benefit smolt emigration by providing cover and refuge, but also potentially have an adverse effect on steelhead smolt emigration by increasing warmwater predator habitat downstream of the Thermalito Afterbay Outlet.

Overall, implementation of the Proposed Project would result in a beneficial effect on steelhead smolt emigration relative to the No-Action Alternative.

C4.4.3.6 Potential Facility Modifications

Although it is not possible to quantify the effects of any future facility modifications on steelhead with the information available at this time, all of the potential facility modifications being studied would likely benefit steelhead due to increased quantity and quality of habitat with suitable water temperature conditions. A qualitative evaluation of the potential effects of future facilities modifications on lower Feather River aquatic habitat is described in Section C4.1.7 above.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Project would result in an overall beneficial effect on steelhead relative to the No-Action Alternative.

C4.4.4 American Shad

C4.4.4.1 Flow-Related Effects

American shad adult immigration occurs during May and June, and spawning occurs during June and July. American shad have been frequently observed in the Feather River from the Thermalito Afterbay Outlet downstream to the confluence with the Sacramento River and only infrequently upstream of the Thermalito Afterbay Outlet to Steep Riffle at RM 61. No changes in flow regimes downstream of the Thermalito Afterbay Outlet are included under the Proposed Project, relative to the No-Project Alternative. Under the Proposed Project, minimum flows in the river reach extending from the Fish Barrier Dam downstream to the Thermalito Afterbay Outlet would be increased from 600 cfs to 700 cfs from April 1 to September 14 and to 800 cfs from September 15 to March 31. Because American shad are observed only infrequently upstream of the Thermalito Afterbay Outlet, an increase in flow in this reach of the river is not anticipated to have any effect on American shad immigration or spawning.

C4.4.4.2 Water Temperature-Related Effects

The reported suitable water temperature range for American shad adult immigration and spawning is 46°F to 79°F, and this life stage occurs from April through June in the lower Feather River (Moyle 2002; DFG 1986; Leggett and Whitney 1972; Painter et al. 1979; USFWS 1995; Walburg and Nichols 1967; Wang 1986). With implementation of the Proposed Project, water temperatures are expected to remain within this broad range. Therefore, no substantial water temperature effects on American shad are anticipated.

C4.4.4.3 Summary of Potential Effects on American Shad

Study plan report summaries addressing project effects on American shad are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1 of the PDEA.

Implementation of the Proposed Project would not alter flows and would have only a slight effect on water temperatures in the HFC compared to the No-Project Alternative. Specifically, there would be no changes in immigration or spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature or flow-related effects on American shad during the initial new license operating period with implementation of the Proposed Project.

C4.4.4.4 Potential Facility Modifications

American shad are not known to utilize the LFC above steep riffle; therefore, upstream facility modifications are not anticipated to have any substantive effect on habitat utilization within the LFC by American shad. Upstream facilities modifications being studied would likely lower water temperatures in the HFC to some extent, but likely would not be of sufficient magnitude to affect American shad. Potential downstream facilities modifications being studied would likely lower water temperatures in the HFC, but also likely would not be of sufficient magnitude to reduce water temperatures below a value that would have biological significance for American shad. Therefore, it is not likely that any of the potential future facility modifications would have any substantive effect on American shad.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Project would not result in any significant effect on American shad relative to the No-Project Alternative.

C4.4.5 Black Bass

C4.4.5.1 Water Temperature–Related Effects

Most black bass inhabiting the lower Feather River occur downstream of the Thermalito Afterbay Outlet. Black bass are considered a warmwater species and although slightly lower water temperatures may occur in the lower Feather River with implementation of the Proposed Project, the magnitude of the cooling would not be sufficient to substantially affect black bass habitat availability. Additionally, there is suitable black bass habitat downstream of the lower Project Boundary where water temperature reductions likely would be negligible.

C4.4.5.2 Summary of Potential Effects on Black Bass

Study plan report summaries addressing project effects on black bass species are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam; Section G-AQUA1.5, Fisheries Management; and Section G-AQUA1.11, Predation, in Appendix G-AQUA1 of the PDEA.

Implementation of the Proposed Project would not alter flows in the HFC. Water temperatures during the initial new license operating period would be slightly reduced in the HFC of the lower Feather River compared to the No-Project Alternative. Specifically, there would be only slight changes in spawning habitat quantity and quality as a result of water temperature changes. Therefore, there would be no significant adverse water temperature and no flow-related effects on black bass with implementation of the Proposed Project during the initial new license operating period.

C4.4.5.3 Potential Facility Modifications

Black bass are not known to utilize the LFC; therefore, upstream facility modifications being studied would not be expected to have any effect on black bass in the LFC. Potential future facilities modifications likely would lower water temperatures in the HFC and may have an adverse effect on the quantity and quality of black bass habitat downstream to the lower Project Boundary. Potential water temperature reductions beyond the lower Project Boundary would diminish with diminishing biological effects until water temperatures reach a range suitable for black bass. The distance downstream of the lower Project Boundary within which adverse water temperature effects on black bass could potentially occur would depend on the magnitude of the flows as well as the daily weather conditions. Because the lower Feather River downstream of the area influenced by water temperatures controlled by the Oroville Facilities would remain suitable habitat for black bass, the overall potential effect of the Proposed Project on habitat availability for this species would be minimal.

Conclusion

Based on the above summary of potential effects, it is likely that the effects of the Proposed Project on black bass would be less than significant relative to the No-Project Alternative.

C4.4.6 Green Sturgeon

C4.4.6.1 Flow-Related Effects

Flows in the portions of the lower Feather River where sturgeon are distributed would not change with implementation of the Proposed Project relative to the No-Project Alternative. Therefore, there would be no flow-related effects on green sturgeon under the Proposed Project.

C4.4.6.2 Water Temperature–Related Effects

Water temperatures downstream of the Thermalito Afterbay Outlet, where sturgeon are known to occur, would cool slightly under the Proposed Project relative to the No-Project Alternative. A review of available literature on suitable water temperatures for different life stages of green sturgeon indicates the following:

- Adult immigration and holding—44°F to 61°F (Beamsderfer and Webb 2002; DFG Website 2002; Emmett et al. 1991; Erickson et al. 2002; USFWS 1995);
- Adult spawning and embryo incubation—46°F to 68°F (Artyukin and Andronov 1990; Beamsderfer and Webb 2002; DFG Website 2002; Cech et al. 2000; Erickson et al. 2002; Moyle et al. 1995; USFWS 1995);
- Juvenile rearing—50°F to 66°F (Moyle 2002; Cech et al. 2000; Conservation Management Website 1996; Farr et al. 2001); and

- Juvenile emigration—50°F to 66°F (Moyle 2002; Adams et al. 2002; Beamsderfer and Webb 2002; Cech et al. 2000; Conservation Management Website 1996; Farr et al. 2001).

Water temperature decreases associated with implementation of the Proposed Project are not expected to fall below minimums specified for each life stage. Therefore, water temperature–related effects on green sturgeon would range from no change, relative to the No-Project Alternative, to slightly beneficial effects.

C4.4.6.3 Summary of Potential Effects on Green Sturgeon

Study plan report summaries addressing project effects on green sturgeon are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; and Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1 of the PDEA.

Implementation of the Proposed Project would not alter flows or decrease water temperatures in the lower Feather River sufficiently to affect green sturgeon compared to the No-Project Alternative. Specifically, there would be no changes in spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature– or flow-related effects on green sturgeon with implementation of the Proposed Project during the initial new license operating period.

C4.4.6.4 Potential Facility Modifications

Green sturgeon are not known to utilize the LFC; therefore, upstream facility modifications being studied would not be expected to have any effect on utilization within the LFC. Potential future facilities modifications likely would lower water temperatures in the HFC but not below a value that would have biological significance for green sturgeon. The potential future facility modifications would likely benefit the adult immigration and holding, adult spawning and embryo incubation, juvenile rearing, and juvenile emigration life stages for green sturgeon by increasing the quantity and quality of available habitat through reduced water temperatures.

Conclusion

Based on the above summary of potential effects, it is likely that effects on green sturgeon under the Proposed Project would be beneficial relative to the No-Project Alternative.

C4.4.7 Hardhead

C4.4.7.1 Water Temperature–Related Effects

Water temperatures in the lower Feather River are expected to be slightly cooler with implementation of the Proposed Project, relative to the No-Project Alternative. The

reported suitable water temperature range for hardhead adult spawning is 55°F to 75°F, and this life stage occurs from April through August in the lower Feather River (Moyle 2002; Cech Jr. et al. 1990; Wang 1986). Slightly lower water temperatures in the lower Feather River are not expected to have any adverse effects on hardhead.

C4.4.7.2 Summary of Potential Effects on Hardhead

Study plan report summaries addressing project effects on hardhead are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, of Appendix G-AQUA1 of the PDEA.

Implementation of the Proposed Project would increase flows and decrease water temperatures in the LFC, relative to the No-Project Alternative. However, there would be no changes to flows and only slight changes in water temperatures in the HFC under the Proposed Project. Therefore, increased flows and decreased water temperatures in the LFC would have no effect on hardhead spawning during the interim period. Similarly, no negative effects on spawning are expected downstream of the Thermalito Afterbay Outlet.

C4.4.7.3 Potential Facility Modifications

Implementation of any of the proposed facility modifications is not likely to have any substantial water temperature effect on the quantity or quality of available habitat for hardhead.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Project would not result in any significant effect on hardhead relative to the No-Project Alternative.

C4.4.8 River Lamprey

C4.4.8.1 Water Temperature–Related Effects

River lamprey reportedly tolerate a relatively broad range of water temperatures for spawning (e.g., 43°F to 72°F [Moyle 2002; Beamish 1980; Kostow 2002; Meeuwig et al. 2003; Meeuwig et al. 2002; Stone et al. 2001; Wang 1986]). Small decreases in water temperature associated with implementation of the Proposed Project, relative to the No-Project Alternative, are not expected to have any effect on river lamprey.

C4.4.8.2 Summary of Potential Effects on River Lamprey

Study plan report summaries addressing project effects on river lamprey are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, of Appendix G-AQUA1 of the PDEA.

Implementation of the Proposed Project would increase flows and decrease water temperatures in the LFC, relative to the No-Project Alternative. However, there would be no significant changes to flows and only slight decreases in water temperatures in the HFC under the Proposed Project. Therefore, water temperature changes in the LFC due to increased flows would have no effect on river lamprey spawning. Additionally, river lamprey would benefit from improved spawning substrate conditions resulting from the gravel supplementation and improvement program.

C4.4.8.3 Potential Facility Modifications

Implementation of any of the potential future facility modifications likely would not result in decreased water temperatures of sufficient magnitude to result in a change in the quantity and quality of available habitat for river lamprey.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Project would result in slightly beneficial effects on River lamprey relative to the No-Project Alternative.

C4.4.9 Sacramento Splittail

C4.4.9.1 Flow-Related Effects

Sacramento splittail have only been reportedly observed in the Feather River downstream of the Thermalito Afterbay Outlet. No changes in flow regimes are anticipated with implementation of the Proposed Project in this portion of the river. Therefore, potential flow-related effects on Sacramento splittail spawning are not included in this analysis.

C4.4.9.2 Water Temperature–Related Effects

Sacramento splittail only inhabit the lower portion of the lower Feather River where water temperature decreases associated with the Proposed Project would likely be undetectable. Therefore, no water temperature–related effects are anticipated with implementation of the Proposed Project relative to the No-Project Alternative.

C4.4.9.3 Summary of Potential Effects on Sacramento Splittail

Study plan report summaries addressing project effects on Sacramento splittail are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, of Appendix G-AQUA1 of the PDEA.

There would be no changes to flows and only minimal decrease in water temperatures in the HFC under the Proposed Project relative to the No-Project Alternative. Because only minimal changes would occur and Sacramento splittail have only been observed in the HFC within the project study area, no flow-related or water temperature–related effects on splittail spawning are expected to occur.

C4.4.9.3 Potential Facility Modifications

Sacramento splittail do not utilize the lower Feather River upstream of the Thermalito Afterbay Outlet. Therefore, implementation of any of the proposed facility modifications is not likely to have any effect on Sacramento splittail in the LFC. Additionally, because the lower Feather River downstream of the area influenced by water temperatures controlled by the Oroville Facilities (i.e., the remainder of the river downstream of the southern project boundary) would remain suitable habitat for Sacramento splittail, the overall potential affect of the Proposed Project on habitat availability for this species would be minimal.

Conclusion

Overall, implementation of the Proposed Project is not anticipated to affect Sacramento splittail.

C4.4.10 Striped Bass

C4.4.10.1 Flow-Related Effects

No changes in flows below the Thermalito Afterbay Outlet would result from implementation of the Proposed Project; therefore, the majority of striped bass habitat would not be affected. Minimum flows in the river reach extending from the Fish Barrier Dam downstream to the Thermalito Afterbay Outlet would increase from 600 cfs to 700 cfs from April 1 to September 14 and to 800 cfs from September 15 through March 31 under the initial new license operating period with implementation of the Proposed Project. Because striped bass are infrequently observed upstream of the Thermalito Afterbay Outlet, an increase in flow in this reach of the river is not anticipated to have any substantive effect on the quantity, quality, or distribution of striped bass habitat.

C4.4.10.2 Water Temperature-Related Effects

Water temperatures downstream of the Thermalito Afterbay Outlet, where striped bass are known to occur, would only cool slightly under the Proposed Project, relative to the No-Project Alternative. Therefore no significant impacts on striped bass spawning are expected as a result of decreased water temperature.

C4.4.10.3 Summary of Potential Effects on Striped Bass

Study plan report summaries addressing project effects on striped bass are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, of Appendix G-AQUA1 of the PDEA.

Implementation of the Proposed Project would increase flows and decrease water temperatures in the LFC, relative to the No-Project Alternative. However, there would be no changes to flows in the HFC under the Proposed Project. Because such changes would not occur and striped bass are frequently observed in the HFC, no flow-related effects on striped bass spawning habitat would occur within most of the areas where

striped bass are observed. Because striped bass are only infrequently observed in the LFC, reduced water temperatures are not likely to substantially affect striped bass spawning during the interim period. Similarly, only minimal decreases in water temperature in the HFC are anticipated under the Proposed Project and would not be of sufficient magnitude to affect striped bass spawning.

C4.4.10.4 Potential Facility Modifications

Striped bass are not frequently observed in the LFC; therefore, upstream facilities modifications would have no effect on striped bass utilization within the LFC, potential future facilities modifications would have the effect of propagating water temperatures similar to those in the LFC farther downstream and could potentially affect the suitability of existing striped bass habitat upstream of the lower Project Boundary. However, because striped bass spawning in the lower Feather River peaks during May and early June (DFG 1971; DeHaven 1979; DeHaven 1977), when water temperature requirements in the LFC rise to 63°F and because striped bass reportedly prefer water temperatures of 50°F to 68°F (Moyle 2002), no negative effects are anticipated on striped bass spawning.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Project would not result in any significant effect on striped bass.

C4.5 REFERENCES

- Berman, C. H. 1990. The Effect of Holding Temperatures on Adult Spring Chinook Salmon Reproductive Success. 915. University of Washington.
- Bond, C. E. (ed.). 1996. Biology of Fishes. Saunders College Publishing. New York, New York.
- Brett, J. R., W. C. Clarke, and J. E. Shelbourn. 1982. Experiments on Thermal Requirements for Growth and Food Conversion Efficiency of Juvenile Chinook Salmon, *Oncorhynchus tshawytscha*. Canadian Technical Report of Fisheries and Aquatic Sciences, No.1127 1–28.
- Bruin, D., and B. Waldsdorf. 1975. Some Effects on Rainbow Trout Broodstock, of Reducing Water Temperature From 59°F to 52°F. U.S. Fish and Wildlife Service, National Fish Hatchery. Hagerman, Idaho.
- Cech, J. J., and C. A. Myrick. 1999. Steelhead and Chinook Salmon Bioenergetics: Temperature, Ration, and Genetic Effects. Technical Completion Report, Project No. UCAL-WRC-W-885. University of California Water Resources Center.

- Cherry, D. S., K. L. Dickson, J. Cairns Jr., and J. R. Stauffer. 1977. Preferred, Avoided, and Lethal Temperatures of Fish During Rising Temperature Conditions. *Journal of the Fisheries Research Board of Canada* 34:239–246.
- Clarke, W. C., and J. E. Shelbourn. 1985. Growth and Development of Seawater Adaptability by Juvenile Fall Chinook Salmon (*Oncorhynchus tshawytscha*) in Relation to Temperature. *Aquaculture* 45:21–31.
- DWR (California Department of Water Resources). 2003. Steelhead Spawning Methods. Interim Report, SP-F10, Task 2B. Oroville Facilities Relicensing, FERC Project No. 2100.
- DWR (California Department of Water Resources). 2004. Phase 2 Report, Evaluation of Project Effects on Instream Flows and Fish Habitat. SP-F16. Oroville Facilities Relicensing FERC Project No. 2100.
- DWR (California Department of Water Resources). 2006. Settlement Agreement for Licensing of the Oroville Facilities. Signed March 21, 2006.
- Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California Salmonid Stream Habitat Restoration Manual—Appendix E: Salmon Spawner Surveys. Fish Document #98. California Department of Fish and Game Sacramento, California.
- Independent Scientific Group. 1996. Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem. Northwest Power and Conservation Council. Portland, Oregon.
- Kamler, E., and T. Kato. 1983. Efficiency of Yolk Utilization by *Salmo gairdneri* in Relation to Incubation Temperature and Egg Size. *Polskie Archiwum Hydrobiologii* 30:271–306.
- Kaya, C. M., L. R. Kaeding, and D. E. Burkhalter. 1977. Use of Cold-Water by Rainbow and Brown Trout in a Geothermally Heated Stream. *The Progressive Fish-Culturist* 39:37–38.
- Kwain, W. 1975. Effects of Temperature on Development and Survival of Rainbow Trout, *Salmo gairdneri*, in Acid Waters. *Journal of the Fisheries Research Board of Canada* 32:493–497.
- Marine, K. R. 1992. A Background Investigation and Review of the Effects of Elevated Water Temperature on Reproductive Performance of Adult Chinook Salmon (*Oncorhynchus tshawytscha*) with Suggestions for Approaches to the Assessment of Temperature Induced Reproductive Impairment of Chinook Salmon Stocks in the American River, California. Department of Wildlife and Fisheries Biology, University of California, Davis.

- Marine, K. R. 1997. Effects of Elevated Water Temperature on Some Aspects of the Physiological and Ecological Performance of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*): Implications for Management of California's Central Valley Salmon Stocks. 915, 1001. University of California, Davis.
- McCullough, D. A. 1999. A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids, with Special Reference to Chinook Salmon. Report No. EPA 910-R-99-010. U.S. Environmental Protection Agency, Region 10. Seattle, Washington.
- McCullough, D. A., S. Spalding, D. Sturdevant, and M. Hicks. 2001. Summary of Technical Literature Examining the Physiological Effects of Temperature on Salmonids—Issue Paper 5. Report No. EPA-910-D-01-005. U.S. Environmental Protection Agency.
- Moyle, P. B. 2002. Inland Fishes of California. University of California Press. Berkeley, California.
- Moyle, P. B., and J. J. Cech. 2000. Fishes, An Introduction to Ichthyology. Prentice-Hall, Inc. Upper Saddle River, New Jersey.
- Nielsen, J. L., T. E. Lisle, and V. Ozaki. 1994. Thermally Stratified Pools and Their Use by Steelhead in Northern California Streams. Transactions of the American Fisheries Society 123:613–626.
- NMFS (National Marine Fisheries Service). 2001. The Effects of Summer Dams on Salmon and Steelhead in California Coastal Watersheds and Recommendations for Mitigating Their Impacts. National Marine Fisheries Service, Southwest Region. Santa Rosa, California.
- ODEQ (Oregon Department of Environmental Quality Standards). 1995. Temperature: 1992–1994 Water Quality Standards Review. Final Issue Paper. Portland, Oregon.
- Ordal, E. J., and R. E. Pacha. 1963. The Effects of Temperature on Disease in Fish.
- Rich, A. A. 1987. Report on Studies Conducted by Sacramento County to Determine the Temperatures which Optimize Growth and Survival in Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*). Prepared for the County of Sacramento.
- USEPA (U.S. Environmental Protection Agency). 2003. USEPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water. Seattle, Washington.
- USFWS (U.S. Fish and Wildlife Service). 1995. Working Paper on Restoration Needs: Habitat Restoration Actions to Double Natural Production of Anadromous Fish in the Central Valley of California. Volume 2. Stockton, California.

- Velsen, F. P. 1987. Temperature and Incubation in Pacific Salmon and Rainbow Trout: Compilation of Data on Median Hatching Time, Mortality and Embryonic Staging. Canadian Data Report of Fisheries and Aquatic Sciences 626. Department of Fisheries and Oceans, Fisheries Research Branch. Nanaimo, British Columbia, Canada.
- Zedonis, P. A., and T. J. Newcomb. 1997. An Evaluation of Flow and Water Temperatures during the Spring for Protection of Salmon and Steelhead Smolts in the Trinity River, California. U.S. Fish and Wildlife Service, Coastal California Fish and Wildlife Office. Arcata, California.

This page intentionally left blank.